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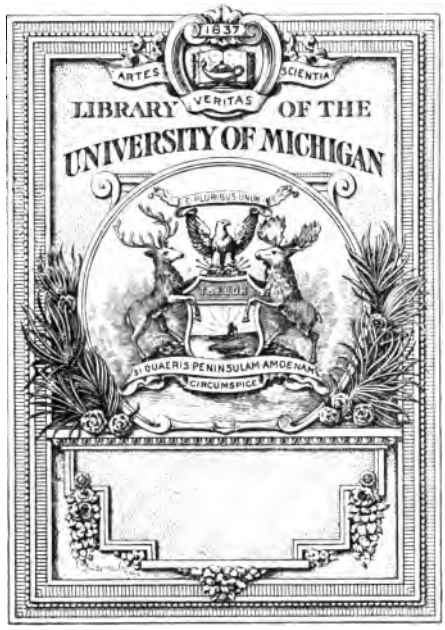

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THE

CIRCULAR, SQUARE, AND OCTAGONAL

EARTHWORKS OF OHIO

BY

CYRUS THOMAS

WASHINGTON
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1889

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THE CIRCULAR, SQUARE, AND OCTAGONAL EARTHWORKS OF OHIO.

By Cyrus Thomas.

OBJECT OF THE PAPER.

The object in view in submitting this paper is to give a summary of the results of a recent survey, by the Mound Exploring Division of the Bureau, of the more noted circular, square, and octagonal works of central and southern Ohio, and incidentally to call attention to some errors in the "Ancient Monuments" of Squier and Davis in regard to them. As most of the errors to be noted are based on internal evidence contained in the Ancient Monuments, reference will first be made to them, after which the Bureau surveys of the same works will be given.

NUMBERS AND MEASUREMENTS IN "ANCIENT MONUMENTS."

Of the seventy-eight different works figured in chapters 1 and 2 of their memoir, relating to "Works of Defense" and "Sacred Inclosures," which include all the groups the authors claim to have examined personally, it appears that Squier and Davis surveyed but twenty-six, or one-third. The descriptions and surveys by Col. Whittlesey and Mr. McBride were furnished to them in manuscript, and appear in print for the first time in Ancient Monuments. Our re-examination has been limited to the still existing works surveyed by them and Col. Whittlesey, which contain circles, squares, or octagons.

So far as a comparison on the ground has been made (which comprises nearly all the works surveyed by them and Col. Whittlesey of the character mentioned, not obliterated) their figures appear, to the eye, generally to be correctly drawn, and in this fact lies the chief value of their work, as their descriptions are brief and usually void of minute details.

The lack of these details, the fact that their measurements are in most cases given in round numbers, and their omission to state whether these measurements were taken from the middle, the inside, or the out-

side of the walls, rendered it necessary to make a resurvey in order to substitute a critical comparison of the works, one with another, as to form and size. This disregard of details and the failure to give a copy of their "field-notes" in any instance (the supposed exception on page 57 will be noticed hereafter) are somewhat surprising in view of the claim made of the accuracy of their surveys, and the following passage in the preface to their memoir:

> At the outset, as indispensable to independent judgment, all preconceived notions were abandoned and the work of research commenced *de novo*, as if nothing had been known or said concerning the remains to which attention was directed; * * care was exercised to note down on the spot every fact which was thought to be of value in the solution of the problems of the origin and purposes of the remains under notice, and particular attention was bestowed in observing the dependencies of the position, structure, and contents of the various works in respect to each other and the general features of the country. Indeed no exertion was spared to insure entire accuracy, and the compass, line, and rule were alone relied upon in all matters where an approximate estimate might lead to erroneous conclusions. The ancient inclosures and groups of works personally examined or surveyed are upwards of one hundred in number.

It is certainly strange, in view of this statement, to find all their measurements of lines and areas given in such round numbers as 250, 300, 800, 900, 1,000, 1,050, and 1,080 feet, and 15, 30, and 50 acres; and not to find in any instance (except one which will be noticed further on) any statement as to where the survey commenced, how it was conducted, or what were the courses and distances run in making it.

As is shown hereafter some of the figures among these monuments approach very closely to geometrical regularity, in fact present somewhat difficult puzzles to those who claim that they were built by Indians; yet these are few, and pertain to a limited locality and to what may be classified as one type of works. However, the exact regularity in form and "coincidence in size," claimed by Messrs. Squier and Davis, applies only to some two or three circles and two or three squares, while some of those of which they make special mention and which they rely upon as furnishing evidence of the truth of their assertions in this respect, and claim to have carefully surveyed in person, not only fail to make good their claim, but prove exactly the opposite.

Turning to pl. XX, representing the ancient works in Liberty Township, Ross County, we find, in a "supplementary plan A," a diagram showing the method of surveying circles, of which an explanation is given in a foot-note on page 57. In this note the authors say:

> To put at once all skepticism at rest which might otherwise arise as to the regularity of these works, it should be stated that they were all carefully surveyed by the authors in person. Of course no difficulty existed in determining the perfect regularity of the squares. The method of procedure, in respect to the circles, was as follows: Flags were raised at regular and convenient intervals, upon the embankments, representing stations. The compass was then placed alternately at these stations, and the bearing of the flag next beyond ascertained.
>
> If the angles thus determined proved to be coincident, the regularity of the work was placed beyond doubt. The supplementary plan A indicates the method of sur-

vey, the "Field Book" of which, the circle being 3,600 feet in circumference, and the stations 300 feet apart, is as follows:

Station.	Bearing.	Distance.	Station.	Bearing.	Distance.
	°	*Feet.*		°	*Feet.*
1	N. 75 E.	300	7	S. 75 W.	300
2	N. 45 E.	300	8	S. 45 W.	300
3	N. 15 E.	300	9	S. 15 W.	300
4	N. 15 W.	300	10	S. 15 E.	300
5	N. 45 W.	300	11	S. 45 E.	300
6	N. 75 W.	300	12	S. 75 E.	300

That the whole thing may be laid before the reader, we insert here an exact copy of their "supplementary plan A." (See Fig. 1).

As the authors are describing the Liberty Township works the reader will naturally infer that this note and supplementary plan have some reference to them. This, however, is a mistake, as the circumference

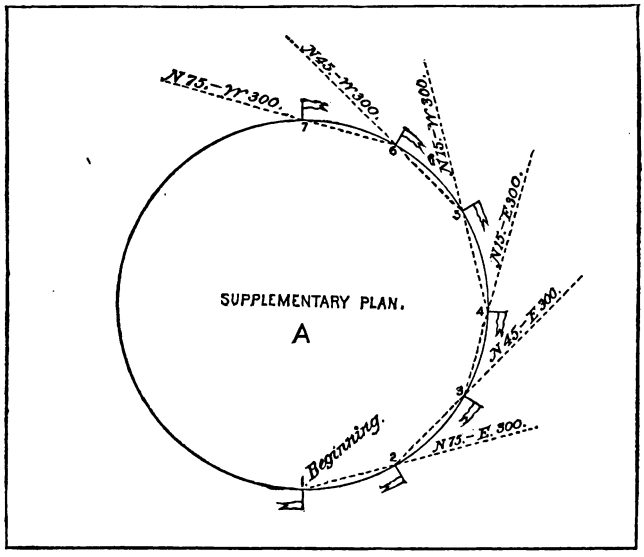

FIG. 1. Copy of "Supplementary Plan," pl. XX, Ancient Monuments.

of the smaller circle is 1,000 feet less than that of the supplementary plan, and that of the larger one, 1,800 feet more. Nor does it refer to any ancient work figured or mentioned in their memoir.

It is therefore disappointing, after the positive assurance in this foot-note of accuracy in the "surveys," and reference to a "Field Book," to find that the authors give as an illustration of their methods a purely imaginary circle, representing no survey by them, as there is no circular inclosure of the dimensions given, either figured or mentioned in their entire memoir. A single glance at the "Field Book" is, of itself, sufficient to convince any one who has surveyed any of these ancient works, or who has examined them carefully, that this is simply a hypothetical illustration. In the first place a chord which will divide the

circumference into equal parts can be found only by first ascertaining the circumference; in the second place it is not possible, even with the utmost care and best instruments, that the angles should be precisely the same and the steps exactly equal throughout, where the top of the circular wall is from 4 to 6 feet wide.

It was probably the intention of the authors that this should be taken as a hypothetical illustration. But why give an imaginary "Field Book" and example when they could have referred to any one of their own surveys? Why do they fail to give a single illustration from their actual work if they placed the full confidence in it which their words imply? Not only is this disappointing to the student of archæology, but the illustration of their methods is not calculated to inspire confidence in the accuracy of their surveys. It is evident from the language of the note and the supplementary plan that the "300 feet" refers to the chords and not to the arcs. As it is not presumable they had a chain or measuring line 300 feet long, the chord would have to be measured by steps, a task which, as any surveyor or mathematician knows, is far more difficult to accomplish than any work our authors were likely to undertake. It is therefore apparent that they have given an illustration which is impracticable and which is not drawn from their own work.

Moreover, the doubts which these facts raise in our minds are not allayed by a resurvey of the Liberty Township works, in connection with which the note and supplementary plan referred to are given.

LIBERTY TOWNSHIP WORKS.

For example, the smaller of the two prominent circles of the Liberty Township group, shown on pl. XX, to which reference has just been made and which they represent as a true circle, with a diameter of 800 feet (certainly a round number where great accuracy is claimed), is in fact an irregular ellipse of the form shown in Fig. 2. The longer diameter, measuring to the middle of the wall, as ascertained by the survey, is 866 feet, and the shorter 748 feet, the difference between the two being 118 feet. This survey was made precisely in the manner suggested by Messrs. Squier and Davis, save that the chords were 100 feet each, except a gap of 313 feet where the wall is too nearly obliterated to be traced satisfactorily; this gap is indicated on the plat (Fig. 2) by dotted lines.

The field-notes of this resurvey are given here, that the critical reader may have before him all the facts, so far as it is possible to put them in print, upon which our conclusions are based.

Beginning at station 1 (see Fig. 2) at the end of the wall on the south side of the gateway leading into the large circle, the courses were run from station to station westward, northward, and around to the place of beginning.[1]

[1] *The measurements are always to be understood as to and along the middle of the walls unless otherwise noted.*

The gap spoken of is in that part of the circle immediately on the south side of the gateway. The stakes marking the stations were set along the top of the wall, as near the middle of it as possible, and 100 feet

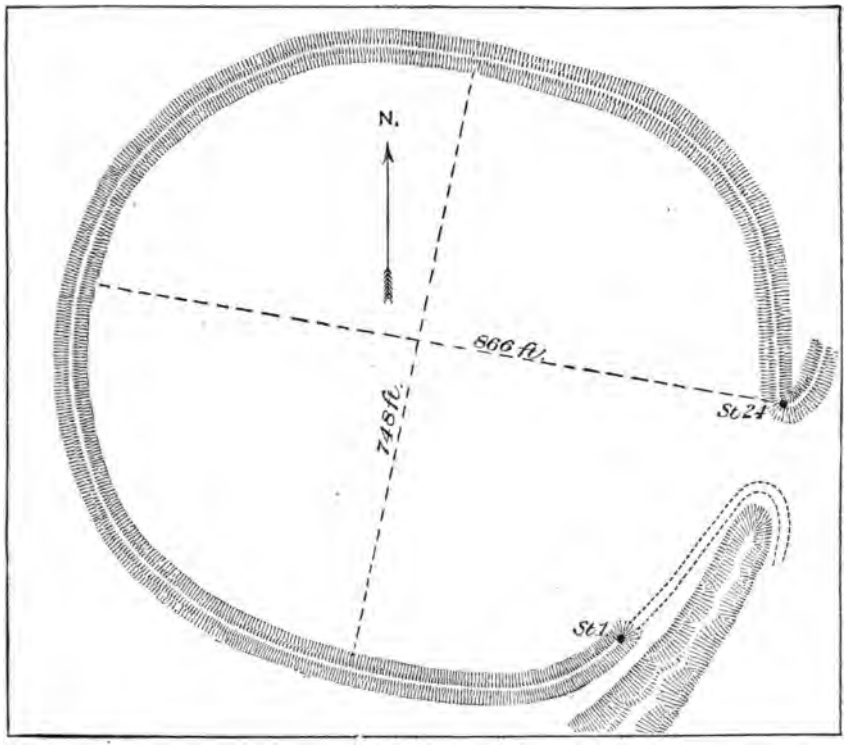

FIG. 2. Small Circle, Liberty Township works, according to re-survey.

apart; the instruments used were a transit and a hundred-foot steel chain.[1]

Small circle, Liberty Township works, Ohio.

Station.	Course.	Distance.	Station.	Course.	Distance.
From—	° ′	*Feet.*	From—	° ′	*Feet.*
1 to 2	S. 60 00 W.	100	13 to 14	N. 53 52 E.	100
2 to 3	S. 81 35 W.	100	14 to 15	N. 67 05 E.	100
3 to 4	S. 84 44 W.	100	15 to 16	N. 84 23 E.	100
4 to 5	N. 74 45 W.	100	16 to 17	S. 81 08 E.	100
5 to 6	N. 70 00 W.	100	17 to 18	S. 73 38 E.	100
6 to 7	N. 59 16 W.	100	18 to 19	S. 71 02 E.	100
7 to 8	N. 42 00 W.	100	19 to 20	S. 65 05 E.	100
8 to 9	N. 24 23 W.	100	20 to 21	S. 39 46 E.	100
9 to 10	N. 12 48 W.	100	21 to 22	S. 20 45 E.	100
10 to 11	N. 5 47 E.	100	22 to 23	S. 7 50 E.	100
11 to 12	N. 20 30 E.	100	23 to 24	S. 0 58 W.	30
12 to 13	N. 34 24 E.	100	24 to 1	S. 32 20 W.	313

[1] In order to avoid repetition it may be stated here that these instruments were used in all the surveys made by the Bureau assistant, Mr. James D. Middleton, which are mentioned in this paper.

As before mentioned, Squier and Davis nowhere state whether their measurements are from the middle, the inside, or the outside of the walls. As the walls are usually from 30 to 40 feet wide, the point of measurement becomes an important item where accuracy is required. From the fact that some of the "sections" in Col. Whittlesey's surveys go to the middle of the walls we have taken for granted, in making comparisons with the surveys of Messrs. Squier and Davis, that this was the rule they adopted.

While pl. XX is before us we may as well notify the reader that the directions are all wrong, the top being east and the left side north; in other words, the large circle is, in fact, directly south of the square and not east as given in the plate, the whole plat having been turned one-quarter round from the true position. The directions marked along the lines of the square should be changed, thus: N. 45° E., to S. 45° E., and N. 45° W. to N. 45° E. So far as could be ascertained from the fragments of the square remaining unobliterated, the walls, although not exactly 45° east and west, vary from these courses only from half a degree to three degrees.

The large circle is now so nearly obliterated that no further survey can be made, yet judging from the figure and dimensions given in the plat, the authors have also made an error here. The diameter, according to the authors, is 1,720 feet and the area 40 acres, whereas a circle with this diameter will embrace an area of 53 acres. It is apparent from the figure that the area inclosed by this part of the works is not less than that of the large circle if complete.

Nevertheless the authors remark, in speaking of these works and comparing them with others of the Scioto Valley:

> These figures are not only accurate squares and perfect circles, but are, in most cases, of corresponding dimensions, that is to say, the sides of the squares are each 1,080 in length, and the diameter of the large and small circles a fraction over 1,700 and 800, respectively. Such were the results of surveys made at different times, the measurements of which correspond within a few feet.

THE NEWARK WORKS.

Attention is next called to the celebrated works near Newark, a plan of which is given by our authors on their pl. XXV, from a careful survey made by Col. Whittlesey. As Col. Whittlesey was noted for his accuracy as a surveyor, the plat, as far as it remains unchanged since leaving his hands, is presumed to be correct, but there are indications that some modifications have been made in it or that in this case Col. Whittlesey has failed to sustain his reputation for accuracy. At any rate there are some marked differences between the text and the plat.

In order that the reader who has not a copy of the Ancient Monuments at hand may clearly understand the points made, a fac-simile of Col. Whittlesey's plat is introduced here. (See Pl. I.)

Speaking of the structure "E," the authors say

This work is not, as has generally been represented, a true circle; its form is that of an ellipse, its diameters being 1,250 and 1,150 feet respectively. There are two or three slight irregularities in the outline; too trifling, however, to be indicated in the plan. The area of the inclosure is something over 30 acres.

The area as indicated on the diagram is "30 acres," hence the fair inference to be drawn from the "something over" in the description is that the area is a fraction over 30 acres. A short calculation will suffice to show that an ellipse having the diameters given above will inclose only 26 acres, precisely the area given to this inclosure by Atwater,[1] and little more than that obtained by the resurvey. We also notice, notwithstanding the authors' statement in the text above quoted, that Col. Whittlesey gives, on the plat (see sections "C, D") the shorter diameter as 1,200 feet, measuring to the middle of the wall on each side. A careful resurvey made by the agent of the Bureau makes the longest diameter 1,189 feet and the shortest 1,163 feet, showing a difference between the extremes of 26 feet. The figure is somewhat elliptical, though not so much so as represented in Ancient Monuments. The curve is not exactly regular. (See Pl. II.)

The field-notes of this survey are given hereafter.

Squier and Davis state in the text that the circular inclosure "F" which connects with the octagon "is a true circle 2,880 feet, or upwards of half a mile, in circumference." The area indicated on the plat (no mention is made of this in the text) is 20 acres, and the diameter given on the plat (section "a-b") is "1,050 feet."

Now, it is evident that a circumference of 2,880 feet, the figure being a true circle, will have a diameter of but 917 feet, showing a difference between the text and the plate of 133 feet. The area of a circle of this size is but a slight fraction over 15 acres.

According to the survey made by the Bureau agents, the field-notes and plat of which are given further on, the diameter from the observatory to the entrance to the octagon is 1,056 feet, and the one crossing this at right angles 1,050 feet, giving an area of 20 acres. Atwater,[1] as nearly as can be ascertained from his survey, made the diameter of this circle 1,100 feet, which gives an area of 22 acres.

The area of the octagon, as indicated on the plate, is "50 acres;" in the text it is stated that it is "something over 50 acres." Atwater, whose estimates of acres are generally more correct than those of Messrs. Squier and Davis, says[2] it contains "about 40 acres." According to our resurvey, the notes of which are given hereafter, this area, including the inner halves of the walls, is but a small fraction over 41 acres.

In their description of the Marietta works (pl. XXVI), after alluding to the earlier notices thereof, they say:

Since that period various descriptions have appeared in print, and a number of plans differing materially in their details have been published. It is of so much importance,

[1] Archæol. Americana, vol. 1 (1820), p. 127 [2] *Ibid.*, p. 126.

however, and has been the basis of so much speculation, that it is time an accurate map and a careful description should be placed before the public. Such a map and such a description it is here aimed to present.

The map they give, according to a note, is drawn from a survey made by Col. Whittlesey, in 1837. Yet, according to their text, the area of the larger square is 40 acres and that of the smaller 20, while on the map that of the former is placed at 50 and that of the latter at 27 acres.

Near the close of their description of these interesting works[1] is this statement:

> The absolute identity in size between the smaller inclosure (which varies a little from a true square) and several of those which occur in the Scioto Valley, should not be overlooked in any attempt to educe the character and design of the group. That there is some significance in the fact is obvious. (See pls. XVI and XVII.)

As the authors fail to give us measurements of this smaller inclosure by which we may judge of "this absolute identity in size," we have only the area as a means of comparison. There is an octagon but no square on pl. XVI, which represents the "High Bank works;" the authors' reference to this is, therefore, erroneous. The sides of the square on pl. XVII, which represents the Hopeton works, are marked 900 feet each. If we assume the area of the smaller Marietta square to be "27 acres," as indicated on the plat, the sides will be about 1,084 feet, agreeing very nearly with those in Paint Creek Valley, but differing widely from the Hopeton square, pl. XVII. If we assume the area to be "20 acres," as given in the text, the sides will measure about 933 feet, but little more than the Hopeton square.

In their description of the ancient works of Montgomery County,[2] figured as No. 1, pl. XXIX, speaking of the large inclosure, they say:

> The diameter of this circle is 100 feet greater than that of the corresponding large circle of the Scioto works [pl. XX], and the same proportionate increase in size is to be observed in the square and lower circle.

By reference to the plates it will be seen that the diameter of the large circle of the Montgomery County works is 1,950 feet and that of the Scioto (Liberty Township) works is 1,720 feet, a difference of 230 feet instead of 100 as stated by the authors.

The area of the octagon at the High Bank works, pl. XVI, as indicated on the plat, is "18 acres," while the average diameter as given in the text is 950 feet (which agrees, as will be shown hereafter, almost exactly with the result of the Bureau surveys). This gives an area lacking but a few rods of 21 acres. On the other hand, they give to the Hopeton square, 900 by 950 feet, an area of 20 acres, which is as nearly correct as can be stated without the introduction of fractions.

SEAL TOWNSHIP WORKS.

The attention of the reader is called next to the "Seal (now Scioto) *Township works*" shown on pl. XXIV. The errors made by Squier

[1] *Ancient Monuments*, page 73. [2] Ibid., page 83.

and Davis in this case are those of measurements. The lengths of the sides of the square, as shown by the notes of the Bureau survey, are 854 feet east and west, and 852 north and south, being an average of 53 feet greater than Messrs. Squier and Davis's measurements. The work is, however, very nearly an exact square.

According to these authors the parallels running north to the circle are 100 feet apart and 475 feet long. According to the resurvey they are 68 feet apart, measuring to the middle line of each wall, and the average length 634 feet (the eastern 647, and western 621). The distance from the square to the break of the ravine is 427 feet for the eastern side, and 400 for the western, the width of the ravine 110 feet.

Some of the errors and inconsistencies we have pointed out may be considered of minor importance, yet when we take into consideration the large number of them, in the face of the repeated assertions of the authors that their surveys were accurately and carefully made, we are compelled to recognize that there has been an inexcusable degree of carelessness, which is calculated to depreciate their work, and to a great extent destroys confidence in their measurements and figures.

Notwithstanding these criticisms, which, as will be seen, relate almost wholly to measurements and to want of care in editing their memoir, the work is of great value; for, as heretofore stated, the figures of those works they personally examined are generally correct. In some cases, it is true, inclosures are represented as true circles which are not such; but this is a very common error in archæological treatises.

RESURVEY OF THE OHIO INCLOSURES.

Having pointed out some of the errors of the "Ancient Monuments," in reference to the measurements and dimensions of the circles, squares, and octagons, we will now present the result of the resurvey of the works by Mr. Middleton, as agent of the Bureau.

"OBSERVATORY CIRCLE," NEWARK.

This circle, which is marked "F" on pl. XXV of the Ancient Monuments, is situated at the extreme west of the great group, and is yet very distinct, being about 3 feet high at the lowest point, the average height being between 4 and 5 feet. Most of the south half is yet in the original forest and has never been injured by the plow; but the north half has been under cultivation for a number of years and is considerably worn. The effect of this wearing is apparent not only in the decrease in height, but in the increase in width of this portion, as shown by the field-notes given below.

The chords in this survey were 100 feet each; the stations were on top of the wall as near the middle line as could be ascertained by measurement and judgment, and the stakes all set before the bearings

were taken. The field-notes are as follows, beginning at statio the middle of the gateway leading to the octagon:

Survey of Observatory Circle.

Station.	Bearing.	Distance.	Width of wall.	Remarks.
	° ′	*Feet.*	*Feet.*	
0 to 1..	S. 38 20 E...	42	0	Station 1 at junction of circle and south pa
1 to 2..	S. 26 20 E...	100	36	
2 to 3..	S. 17 37 E...	100	35	
3 to 4..	S. 6 00 E...	100	38	
4 to 5..	S. 5 36 W..	100	38	
5 to 6..	S. 15 00 W..	100	37	
6 to 7..	S. 27 45 W..	100	36	Center of wall 2 feet east; that is, outward.
7 to 8..	S. 35 17 W..	100	34	
8 to 9..	S. 48 40 W..	100	37	
9 to 10..	S. 58 16 W..	100	37	
10 to 11..	S. 69 13 W..	100	37	
11 to 12..	S. 82 00 W..	100	35	
12 to 13..	N. 89 13 W .	100	41	
13 to 14..	N. 76 23 W .	100	37	
14 to 15..	N. 66 15 W..	100	38(?)	Width estimated, not measured.
15 to 16..	N. 55 56 W..	100	39	
16 to 17..	N. 45 10 W..	100	.....	("Observatory.")
17 to 18..	N. 33 33 W..	100	39	
18 to 19..	N. 20 29 W..	100	42	
19 to 20..	N. 11 22 W..	100	43	
20 to 21..	N. 1 34 W..	100	40	
21 to 22..	N. 9 06 E ..	100	39	
22 to 23..	N. 20 54 E ..	100	38	
23 to 24..	N. 31 12 E ..	100	39	
24 to 25..	N. 42 32 E ..	100	40	
25 to 26..	N. 53 43 E ..	100	42	
26 to 27..	N. 62 43 E ..	100	40	
27 to 28..	N. 75 07 E ..	100	44	
28 to 29..	N. 86 23 E ..	100	40	
29 to 30..	S. 82 17 E ..	100	44	
30 to 31..	S. 72 04 E ..	100	42	
31 to 32..	S. 60 45 E ..	100	45	
32 to 33..	S. 51 06 E ..	100	45	
33 to 34..	S. 46 29 E ..	20	.....	Junction with north parallel wall.
34 to 0..	S. 38 20 E ..	42	.....	Middle of gateway.
34 to 36..	N. 52 04 E ..	295	.....	North parallel.
1 to 37..	N. 51 53 E ..	293	.....	South parallel.

Check Lines.

0 to 11..	S. 18 28 W..	883	.....	
0 to 17..	S. 51 27 W..	1057	.....	
0 to ½..	S. 52 00 W..	.....	.....	"½" indicates the half-way point in the ci ence.
0 to 25..	N. 85 10 W..	770	.....	
17 to 11..	S. 71 59 E...	570	.....	
17 to 25..	N. 4 23 E...	728	.....	
25 to 11..	S. 28 03 E...	1024	.....	

In order to bring before the eye of the reader the approximate larity of this circular work a figure, laid off to a scale, is intro here (Pl. III). The solid black line of short chords marks the l the survey along the top of the wall and the circular dotted lin nearest approximate circle. Great care was taken in making th vey, and the plat and calculation were found to confirm the acc claimed.

Measuring the various diameters the maximum is found to be feet and the minimum 1,050, the mean of which is 1,054.5 feet, bu found by trial that the nearest approximate circle has a diame

1,054 feet. The widest divergence between the line of the survey and the circumference of the true circle is 4 feet.

The aggregate length of the chords surveyed is 3,304 feet, while the circumference of the approximate circle is 3,311 feet; adding to the sum of the chords the additional length of the arcs they subtend (0.1508 of a foot to each 100-foot chord), and we have a total of 3,309 feet. It is therefore evident that the inclosure approaches in form very nearly an absolute circle.

The inference to be drawn from the fact that this and a few other inclosures noticed in this paper are so nearly true geometrical figures will be briefly discussed hereafter.

"OCTAGON," NEWARK, OHIO.

This inclosure, which is connected with the "Observatory Circle," is shown in Pl. IV. The southern portions, *a* to *b*, and *b* to *c*, remain almost uninjured, being still more or less covered by the original forest growth. The other lines of wall have been considerably worn by the plow, though they are still quite distinct, the height not being less at any point than 2½ feet as shown by the figures of the field-notes. Nevertheless the wearing makes it difficult, often impossible, to determine with absolute certainty the middle line, though there is never any good reason why the survey should vary from the middle line of this or any other of these Ohio inclosures, distinctly traceable, more than 3 feet at most.

The field-notes of the survey are as follows: Commencing at station No. 36 (so numbered in the survey of the Observatory Circle) at the point where the northern parallel joins the Octagon; thence to station 37, the point where the southern parallel joins the Octagon, thence to *b* and round to the place of beginning.

Survey of the Octagon.

Station.	Bearing.	Distance.	Width of wall.	Height of wall.
	° ′	*Feet.*	*Feet.*	*Feet.*
36 to 37	S. 36 32 E	82		
37 to *b*	S. 49 41 E	580	40 to 43	5.7 to 4.5
b to *c*	N. 64 18 E	624.5	37 to 48	4.3 to 4.2
c to *d*	N. 39 50 E	625	47 to 39	5.9 to 5.8
d to *e*	N. 25 28 W	622	41 to 50	3.4 to 3.5
e to *f*	N. 51 32 W	621	40 to 37	2.5 to 2.6
f to *g*	S. 65 40 W	613	47 to 43	3.8 to 4
g to *h*	S. 39 15 W	621.5	45 to 47	4.3 to 4
h to 37	S. 25 40 E	581.5	43 to 41	3.8 to 3.7

The two numbers to each course in the width and height columns are two measurements of each wall near the ends in the direction of the survey.

The stations indicated by letters are at the intersections of the lines of the walls: Station *a* is at the intersection of the lines *h*–36 and 37–*b*.

The diameters as ascertained from the plat (in all cases to the intersections) are as follows:

From *h* to *b*	1,218 feet.	From *b* to *d*	1,219 feet.
From *d* to *f*	1,213 feet.	From *f* to *h*	1,202 feet.
From *b* to *f*	1,708 feet.	From *h* to *d*	1,720 feet.
From *a* to *e*	1,483 feet.	From *g* to *c*	1,487 feet.

The widths of the gateways are as follows, the measurements being from base to base:

That at *a* 46 feet; at *b* 23 feet; at *c* 47 feet; at *d* 26 feet; at *e* 37 feet; at *f* 12 feet; at *h* 60 feet.

The angles at the crossings of the diagonals and diameters at the center *o* are so nearly right angles as to be worthy of notice in this connection. For instance, the angles at crossing of the diagonals *bf* and *dh* differ but 10′ from true right angles; while those at the crossing of the diameters *ae* and *cg* differ but 2′.

The inner angles at the intersection of the lines of the walls, that is to say the angles of the octagon, are as follows:

At *a*	155° 59′	At *b*	113° 59′
At *c*	155° 32′	At *d*	114° 42′
At *e*	153° 56′	At *f*	117° 12′
At *g*	153° 35′	At *h*	115° 05′

The very slight differences in the courses of the opposite sides, which in a true figure should be parallel, should not be overlooked.

That between *ab* and *ef* is 1° 51′; between *bc* and *fg* is 1° 22′; between *cd* and *gh* is 35′; between *de* and *h* 36 is 12′.

THE SQUARE AT NEWARK.

This is the smaller square inclosure on the east side of the Newark works, and in pl. XXV, Ancient Monuments, is directly east of the pond. It connects with the fair-ground circle (E on the plate) by a broken line of parallels. According to Col. Whittlesey's plat it varies considerably from a true square, being distinctly narrowed on one side, but, as will be seen from the notes of the resurvey, it must have been very nearly square. As it is well-nigh obliterated it was found impossible to trace the lines throughout, hence only those parts are marked in the figure (see Pl. V) which were satisfactorily determined; the untraced portions are represented by dotted lines.

The following are the field-notes of the resurvey, which commenced near the middle of the southeastern line of wall at 1, running thence to 2, and so on around, following the walls to station 7, whence, as the wall was visible no further, the close was made by running directly to station 1.

Survey of the square.

Station.	Bearing.	Distance.
	° ′	*Feet.*
1 to 2	N. 47 16 E	369.5
2 to 3	N. 41 53 W	928
3 to 6	S. 47 47 W	926
6 to 7	S. 41 47 E	541
7 to 1	N. 82 47 E	679

Check lines.

	Feet.
From 3 to 4, junction with eastern parallel	268
From 4 to 5, junction with western parallel	158
From 5 to 6, western corner	500

The inner angles as ascertained by measurement on the ground are as follows:

At station 1	144 30
At station 2	90 51
At station 3	89 40
At station 6	90 26
At station 7	124 34

Supposing the obliterated parts of the lines about the southern corner to have been straight continuations of the remaining portions, as represented in Pl. V, this angle would equal 89° 03′; and the side 6 to 8 would be 939 feet, and 8 to 2 would be 951 feet.

There are at present no indications whatever of the inner mounds represented on Col. Whittlesey's plat.

As will be seen by inspecting our Pl. V and referring to the notes of the resurvey this inclosure varies but slightly from a true square, the course of the opposite sides in one case differing but 31′ and in the other but 6′. The greatest variation at the corners from a true right angle is 57′.

The length of the diagonal from station 2 to 6 is 1,307 feet, ascertained from plat carefully drawn to a large scale.

FAIR-GROUND CIRCLE.

(See Pl. II.)

This is the large circle of the Newark works situated in the southern extremity of the group and marked E on Pl. XXV of Ancient Monuments, and has received the above name from the fact that it embraces within its circuit the fair-grounds of the Licking County Agricultural Society. It is undoubtedly one of the best preserved ancient monuments of our country, being uninjured by the plow, and trees of the original forest are still standing on it. The ditch has been but slightly filled by the wash of the many years which have passed since its abandonment. The wall varies in width from 35 to 55 feet and in

height from 5 to 14 feet. The ditch varies in width from 28 to 41 and in depth from 8 to 13 feet.

The following are the notes of a survey by Mr. Middleton in 1 commencing at station 1, in the gate-way:

Survey of the Fair-Ground Circle.

Stations.	Bearings.	Distances.	Width of embankment.	Width of ditch.	Stations.	Bearings.	Distances.	Width of embankment.
	° ′	*Feet.*	*Feet.*	*Feet.*		° ′	*Feet.*	*Feet.*
1 to 2..	S. 20 22 E.....	100	55	.....	24 to 25..	N. 27 39 E	100	38
2 to 3..	S. 1 34 E.....	100	45	41	25 to 26..	N. 36 32 E	100	35
3 to 4..	S. 2 55 W.....	100	57	.....	26 to 27..	N. 45 04 E	100	36
4 to 5..	S. 15 17 W.....	100	44	41	27 to 28..	N. 52 40 E	100	38
5 to 6..	S. 23 32 W.....	100	40	.....	28 to 29..	N. 59 37 E	100	43
6 to 7..	S. 28 59 W.....	100	44	.....	29 to 30..	N. 68 44 E	100	46
7 to 8..	S. 39 50 W.....	100	45	.....	30 to 31..	N. 84 15 E	100	43
8 to 9..	S. 49 25 W.....	100	42	42	31 to 32..	S. 85 32 E	100	42
9 to 10..	S. 60 37 W.....	100	47	.....	32 to 33..	S. 77 07 E	100	42
10 to 11..	S. 71 25 W.....	100	44	.....	33 to 34..	S. 63 22 E	100	38
11 to 12..	S. 80 31 W.....	100	43	38	34 to 35..	S. 56 01 E	100	41
12 to 13..	N. 88 50 W.....	100	39	.....	35 to 36..	S. 49 30 E	100	40
13 to 14..	N. 79 33 W.....	100	40	.....	36 to 37..	S. 40 18 E	100	49
14 to 15..	N. 74 13 W.....	100	43	37	37 to 38..	S. 38 29 E	40	53
15 to 16..	N. 59 32 W.....	100	38	.....	38 to 1..	S. 20 22 E	89	.....
16 to 17..	N. 52 32 W.....	100	40	.....	*a* to *b* ..	S. 23 25 W.....	838	.....
17 to 18..	N. 40 26 W.....	100	41	.....	*a* to *c* ..	S. 68 38 W.....	1,190	.....
18 to 19..	N. 32 24 W	100	41	36	*b* to *d*..	N. 20 45 W.....	1,186	.....
19 to 20..	N. 24 44 W.....	100	43	.....	*b* to *c* ..	.....	839	.....
20 to 21..	N. 12 20 W.....	100	42	32	*c* to *d*..	.....	837	.....
21 to 22..	N. 3 20 W.....	100	39	.....	*a* to *d*..	.....	834	.....
22 to 23..	N. 7 55 E	100	38	.....	37 to 39..	N. 66 41 E	84	53
23 to 24..	N. 21 25 E	100	36	.....	2 to 50..	N. 66 27 E	95	48

* N. wing. † S. wing.

From the plat made according to these figures we ascertain tha longest diameter, namely, that running northeast and southwe 1,189 feet; and the shortest—southeast and northwest—is 1,163 fe difference of 26 feet. Although not a true circle, the difference bet the longest and shortest diameters falls much short of 100 fe stated by Messrs. Squier and Davis.

CIRCLE OF THE HIGH BANK WORKS. (ANC. MONUMENTS, PL. XVI.)

These works occupy a broad, unbroken level of the drift terrace, w has been cultivated almost annually since 1845. The walls of th cle and octagon are still quite prominent, and are respectively 2 a feet high. (See Pl. VI.)

This circle is very similar in size and other respects to the "Obs tory Circle" at Newark, and, like that, is connected with an octa though the relative sizes of the two inclosures differ in this respect octagon of the Newark works is larger than the circle, while that o High Bank works is smaller than the circle. We see in this grou tendency to combine circles, octagon, and parallels as at New making it probable that the works at both points are due to one pe According to Messrs. Squier and Davis this circle is a "perfect" the diameter being 1,050 feet, which, as will be seen by what foll *agrees* very closely with the result of the resurvey.

The notes of the resurvey, as copied from Mr. Middleton's field-book, are as follows, commencing in the center of the gate-way leading to the octagon:

Survey of Circle of the High Bank works.

Stations.	Bearings.	Distances.	Width of wall.	Stations.	Bearings.	Distances.	Width of wall.
	° ′	*Feet.*	*Feet.*		° ′	*Feet.*	*Feet.*
1 to 2..	S. 62 37 W	75	30	24 to 25..	N. 63 38 E	75	36
2 to 3..	S. 66 38 W	75	30	25 to 26..	N. 75 00 E	75	34
3 to 4..	S. 68 00 W	75	32	26 to 27..	N. 78 00 E	75	35
4 to 5..	S. 80 34 W	75	44	27 to 28..	S. 88 00 E	75	32
5 to 6..	N. 89 30 W	75	40	28 to 29..	S. 85 00 E	75	30
6 to 7..	N. 78 18 W	75	32	29 to 30..	S. 77 00 E	75	30
7 to 8..	N. 75 30 W	75	33	30 to 31..	S. 64 30 E	75	32
8 to 9..	N. 66 30 W	75	34	31 to 32..	S. 61 52 E	75	28
9 to 10..	N. 57 28 W	75	34	32 to 33..	S. 42 48 E	75	32
10 to 11..	N. 45 00 W	75	34	33 to 34..	S. 40 00 E	75	30
11 to 12..	N. 41 00 W	75	39	34 to 35..	S. 35 00 E	75	34
12 to 13..	N. 34 14 W	75	42	35 to 36..	S. 26 00 E	75	32
13 to 14..	N. 26 10 W	75	44	36 to 37..	S. 21 45 E	75	28
14 to 15..	N. 15 00 W	75	44	37 to 38..	S. 4 45 E	75	26
15 to 16..	N. 7 30 W	75	40	38 to 39 .	S. 2 00 E	75	32
16 to 17..	N. 3 36 W	75	44	39 to 40..	S. 0 30 W	75	30
17 to 18..	N. 8 00 E	75	36	40 to 41..	S. 6 14 W	75	26
18 to 19 .	N. 16 35 E	75	40	41 to 42..	S. 19 00 W	75	28
19 to 20..	N. 22 00 E	75	34	42 to 43..	S. 39 00 W	75	30
20 to 21..	N. 34 00 E	75	32	43 to 44..	S. 43 30 W	75	30
21 to 22..	N. 40 00 E	75	32	44 to 45..	S. 47 25 W	75	.....
22 to 23..	N. 47 15 E	75	38	45 to 1..	S. 48 49 W	21.5	.....
23 to 24..	N. 58 30 E	75	34				

Supplementary.

	° ′	*Feet.*		*Feet.*
a to *b*	N. 81 20 W	744	*b* to *c*	746
a to *c*	N. 36 28 W	1,056	*c* to *d*	743
a to *d*	N. 8 00 E	741	*b* to *d*	1,042

a to *e* S. 36 00 E. Direction of entrance to Octagon.

Plotting the figure carefully from these notes, and then drawing the nearest possible coincident circle, we obtain results similar to those obtained by the survey of the Observatory circle at Newark. This is shown in Pl. VI. In this figure the solid black line of short chords running along the middle of the wall marks the actual line of survey, while the dotted line is the nearest approximate circle, the center of which is at the intersection of the two designated diameters.[1] These diameters are actually surveyed lines, and relate to the line of chords. The middle of that running from *d* to *b* is at the intersection; but the middle of that running from *a* to *c* is about 2 feet from the intersection toward *c*.

The somewhat unexpected results to which allusion has been made in reference to this and the Observatory circle are, first, that the figure is so nearly a true circle; and, second, that the radius is almost an exact multiple of the surveyor's chain. It is true that Messrs. Squier and Davis assert that this and some other inclosures are perfect circles, but their many errors in regard to dimensions, and our belief in the Indian origin of these works, led us to take this assertion cum grano

[1] The scale on the plate is 135 feet to the inch.

salis. We were therefore surprised to find after a very careful survey the close approximation to a true circle in these cases.

As it is impossible to show this satisfactorily in a figure on the scale given here, the attention of the reader is called to the following facts, which he can verify independently by making for himself a plat on a larger scale from the notes given above relating to the High Bank circle.

(1) The chords forming the sides of the inclosed quadrilateral subtend equal arcs of the surveyed line; that is to say, the distance along the wall from *a* to *b* is equal to that from *b* to *c*, also to that from *c* to *d* and from *d* to *a*; the distance in each case being 830.4 feet, or one-fourth of the circumference according to the survey. As these chords are respectively 744, 746, 743, and 741 feet in length, showing an extreme variation of less than 3 feet from a medium and of but 3 feet from a true quadrant, we have an evidence of the close approximation to a true circle.

(2) The extreme difference between the various diameters (except at the eccentric point at the southeast, between the gate-ways) does not exceed 3 feet, or a variation from the medium of 4 feet, and from that of the true circle of more than 5 feet.

(3) A circle with a radius of 526 feet and center at the intersection of the two given diameters varies at no point from the surveyed line (except at the eccentric point in the southeast) more than 6 feet; or, in other words, both would fall on a wall only 6 feet wide.

It is evident, therefore, that we have here a very close approximation to a true circle.

OCTAGON OF THE HIGH BANK WORKS. (See Plate VII.)

The Octagon at this point differs from that at Newark chiefly in size and a closer approximation to a square. The variation from the usual form resulting from throwing the gate-way along the wall between the angles is readily accounted for by the fact that there is here a somewhat abrupt depression, which is avoided by the curve given the wall. The field-notes of the resurvey are as follows—commencing at station 1, in the middle of the gate-way leading to the circle:

Survey of the Octagon of the High Bank works.

Station.	Bearing.	Distance.	Station.	Bearing.	Distance.
	° ′	*Feet.*		° ′	*Feet.*
1 to 2	N. 60 03 E	448	8 to 9	N. 53 37 W	144
2 to 3	S. 43 50 E	419	9 to 10	N. 42 57 W	278
3 to 4	S. 30 17 E	442	10 to 11	N. 31 27 W	417
4 to 5	S. 44 15 W	449	11 to 1	N. 43 27 E	482
5 to 6	S. 60 43 W	340	5 to 12	S. 60 43 W	470
6 to 7	S. 70 41 W	65	12 to 10	N. 42 57 W	453
7 to 8	N. 86 45 W	60			

The lengths of the sides, diameters, and diagonals ascertained from a carefully drawn plat of large scale are as follows:

	Feet.		Feet.
From 11 to 2	908	From 1 to 5	1,008
From 2 to 4	883	From 3 to 10	1,005
From 4 to 12	910	From 4 to 11	1,250
From 12 to 11	868	From 2 to 12	1,272

The inner angles are as follows:

	° ′		° ′
That at station 1 contains	163 24	That at station 5 contains	163 32
That at station 2 contains	103 53	That at station 12 contains	103 40
That at station 3 contains	166 27	That at station 10 contains	168 30
That at station 4 contains	105 28	That at station 11 contains	105 06

It is apparent from these figures and from the plat (Pl. VII.) that this inclosure is comparatively regular, the opposite angles with one exception differing less than half a degree and the exceptional one differing from its opposite but 2°.

Nevertheless the regularity is not such as would be expected from the use of instruments.

The diameter as given by Messrs. Squier and Davis is 950 feet, and the area according to their calculation is 18 acres. According to the resurvey the diameter in one direction (measuring to the intersections of the middle lines of the walls) is 1,008 feet and in the other 1,005. That Messrs. Squier and Davis are to be understood as counting to the middle of the walls is to be inferred from the fact that the diameter of the circle was evidently measured in this way. Assuming they were correct in reference to the circle it follows, of necessity, that their measurements of the octagon are erroneous, the diameter given being 50 feet too short, and the area 2.6 acres too small, 20.6 acres being the true area.

HOPETON WORKS. (ANC. MON., PL. XVII.)

The only parts of this group we notice here are the large circle and the connected square.

These works are situated on the general level of the Scioto Valley, designated by Squier and Davis "the second terrace," which here stands about 30 feet above the river level. The walls of the circle and square are yet very distinct, and with the exception of a single break in the circle can be readily traced. In fact, the lowest point of the square is yet 5 feet high. The circle is more worn, the western half averaging about 2 feet high, while the eastern half is lower, fading out for a short distance near the northeast corner of the square. They are situated close to the foot of the bluff which forms the slope to the upper level, here between 30 and 40 feet above that on which the work stands.

As will be seen by reference to the plate in Ancient Monuments, instead of a passage-way between the circle and square, the two are here in direct contact, part of the circular wall forming a large portion of the *north line of* the square.

Mr. Middleton's field-notes of the survey of these are as follows:

First, the square.—The square, in this case, was station 1 at the southwest corner at the intersection of the two adjoining lines of wall.

Survey of the square of the Hopeton works.

Station.	Bearing.	Distance.	Remarks.
	° ′	*Feet.*	
1 to 2	N. 20 17 W.	244	To center first gateway.
2 to 3	N. 17 10 W.	336.5	To the end of wall at second gateway.
3 to 4	N. 8 00 W.	55.5	Across the second gateway.
4 to 5	N. 12 02 W.	324	To intersection at northwest corner of the square.
5 to 6	N. 70 27 E.	283	To the wall of circle.
6 to 7	N. 70 27 E.	508	To the intersection at northeast corner of square.
7 to 8	S. 54 00 E.	115	To first gateway.
8 to 9	S. 27 00 E.	207	To second gateway.
9 to 10	S. 19 00 E.	355	To gateway of small circle.
10 to 11	S. 2 00 W.	331	To intersection at southeast corner.
11 to 12	S. 68 00 W.	201	To first gateway.
12 to 13	S. 71 21 W.	340	To second gateway.
13 to 1	S. 72 25 W.	285	To place of beginning.

Second, the circle.—The commencement on the south side at station 6 where the circle connects with the wall of the square running from station to station.

Survey of the circle of the Hopeton works.

Station 6 to—	Bearing.	Distance.	Width of wall.	Remarks.
	° ′	*Feet.*	*Feet.*	
14	N. 71 53 W.	100	42	
15	N. 63 39 W.	100	38	
16	N. 55 29 W.	100	40	
17	N. 41 00 W.	100	42	
18	N. 25 21 W.	100	44	
19	N. 12 20 W.	100	45	
20	N. 0 30 E.	100	44	
21	N. 14 52 E.	100	46	
22	N. 22 40 E.	100	42	
23	N. 33 28 E.	100	41	
24	N. 47 57 E.	100	40	Outside half of wall worn.
25	N. 55 57 E.	100	43	
26	N. 63 45 E.	100	40	
27	N. 78 22 E.	100	40	
28	S. 86 04 E.	100	45	
29	S. 81 24 E.	100	40	Base outlines not easily traced.
30	S. 64 05 E.	100	36	Do.
31	S. 53 27 E.	100	.....	Outlines obliterated. Width not ascertained.
32	S. 46 20 E.	100	36	
33	S. 40 15 E.	100	.....	Do.
34	S. 20 16 E.	100	30	Outlines not easily traced.
35	S. 5 32 E.	100	30	Do.
36	S. 4 10 W.	100	38	Do.
37	S. 16 48 W.	100	39	Station on end of wall.
38	S. 31 56 W.	100	.....	Wall obliterated between stations 36 and 37.
39	S. 42 00 W.	100	48	18 feet back to center of end of wall of square.
40	S. 57 11 W.	100	41	
41	S. 63 35 W.	100	43	
42	S. 65 31 W.	100	40	Station on end of wall at gateway. Gateway 35 feet wide.
43	S. 86 11 W.	100	41	
To 6	N. 84 32 W.	98	40	

Check lines.

6 to 20	N. 38 35 W.	634	.....	
6 to 28	N. 10 09 E.	968.5	.....	
6 to 36	N. 57 17 E.	726	.....	
20 to 28	N. 51 04 E.	723	.....	
20 to 36	S. 84 09 E.	1,015	.....	
28 to 36	S. 38 37 E.	711	.....	

These inclosures are drawn to a regular scale in Pls. VIII and IX.

It is apparent from Pl. VIII, which represents the square according to the resurvey, that the form given in Ancient Monuments, Pl. XVII, is erroneous in that it is much more regular than the facts warrant. Neither side is straight, nor is there a right angle at any point. It is not regular in any sense, but was doubtless intended for a square. Measuring the direct lines from corner to corner the lengths are as follows: That from stations 1 to 5, is 957 feet; from 5 to 7, is 791 feet; from 7 to 11, is 962 feet, and from 11 to 1, is 825 feet. Messrs. Squier and Davis say it is a rectangle with a length of 950 feet and a width of 900 feet.

The circular inclosure (Pl. IX) varies considerably from a true figure, the east and west diameter being 1,018 feet, while that running north and south is only 960 feet, the difference between the two being 58 feet. Nor is the curve uniform, being much sharper at some points than at others.

LIBERTY TOWNSHIP WORKS. (ANC. MON., PL. XX.)

These works have been much injured by the plow, the large circle being almost entirely obliterated. There is also a considerable gap in the small circle untraceable. The walls of the square as well as the inclosed mounds have been worn down until at present they are only from one to two feet high.

As the smaller circle has already been described and figured and the field-notes of the resurvey given, no further notice will be taken of it here.

The square.—This inclosure, shown in Pl. X, presents quite a regular figure closely approximating a square. Mr. Middleton's field-notes are as follows, commencing at station *a*, the southern corner; the stations are at the intersections of the lines of the walls:

Survey of the square of Liberty Township works.

Station.	Bearing.	Distance.
	° ′	*Feet.*
a to *b*	N. 47 14 E	1,108
b to *c*	N. 42 41 W	1,106
c to *d*....	S. 47 06 W	1,110
d to *e*	S. 44 11 E	535
e to *a*....	S. 41 24 E	568

The notes showing the position of the arm *fg* leading to the large circle are as follows:

	Feet.
From *e* to *f*: S. 41° 24′ E.....	521
From *f* to *g*: N. 84° 10′ W	185

A direct line from *a* to *d* runs N. 42° 52′ W., exactly 1,100 feet.

The survey was in fact made by triangulation; the angles being as follows:

At *a* (*e a b*)	88° 38′
At *b* (*a b c*)	90° 05′
At *c* (*b c d*)	89° 47′
At *d* (*c d e*)	88° 43′
At *e* (*d e a*)	182° 47′

The angles at *a* and *d*, using the direct line between them, are as follows:

At *a* (*d a b*)	90° 06′
At *d* (*c d a*)	90° 02′

The following are the check lines:

	Feet.
Diagonal from *a* to *c* N. 3° 40′ E	1,566
Diagonal from *b* to *d*	1,561
Diameter running northeast and southwest	1,095
Diameter extended to the direct line between *a* and *d*	1,102
Diameter running northwest and southeast	1,104

These diameters are measured from the middle of the gateways in the sides.

THE BAUM WORKS. (ANC. MON., PL. XXI, NO. 1.)

Although a complete resurvey of these works was made it is not thought necessary to introduce here the notes relating to any part except the square. We may remark, however, that the resurvey of the circular portion revealed no very essential variation from the figure given in Ancient Monuments.

The square, most of which has long been in a pasture, is rather more distinct and prominent than such remains usually are, the walls being from 2 to 4 feet high and the gateways well marked, though no traces of the inclosed mounds remain. The circular portions of the works are much worn, and two sections of considerable length are so nearly obliterated that the line can not be traced through them with any certainty.

Mr. Middleton's field-notes relating to the square are as follows, commencing at station *a* at the western corner:

Survey of the square of the Baum works.

Station.	Bearing.	Distance.	Width of wall.	Length of sides (whole length).
	° ′	*Feet.*	*Feet.*	*Feet.*
a to *b*	N. 59 17 E.	551	49	1,10
b to *c*	N. 59 17 E.	557	56	
c to *d*	S. 30 12 E.	561	50	1,12
d to *e*	S. 30 12 E.	568	35	
e to *f*	S. 59 44 W.	556	33	1,11
f to *g*	S. 59 44 W.	557	33	
g to *h*	N. 29 56 W.	560	56	1,11
h to *a*	N. 29 56 W.	557	57	

For the arm leading to large circle (given only in part here) begin at station *c* at the north corner of the square, and run as follows:

Survey of arm connecting circle and square.

Station.	Bearing.	Distance.	Remarks.
	° ′	*Feet.*	
c to *k*	S. 30 12 E.....	102	*k* indicates the point where the arm connects with the square.
k to 1 ...	S. 81 00 E.....	54	
1 to 2	S. 63 21 E.....	50	
2 to 3	S. 52 21 E.....	50	
3 to 1	S. 64 00 E.....	145	1 indicates the end of the portion of the arm shown in the figure.

Check lines.

h to *d*	N. 59 27 E.....	1,112	
g to *c*	N. 14 29 E.....	1,581	
b to *f*	S. 30 00 E.....	1,124	

The angles at the corners are—

a	90° 47′	*e*	90° 04′
c	89° 20′	*g*	89° 40′

It is apparent from these notes and Pl. XI, representing this inclosure, that it approximates very closely a true square. The greatest variation at the corner from a right angle is only 47′. The average length of the sides is 1,117 feet, from which the extreme variation is only 12 feet, the difference between extremes being but 21 feet.

As the structure and contents of the few mounds which appear to be connected with these works may have some bearing on the question of the origin, age, and uses of the circles and squares, the description will be given here of one connected with the Baum works just mentioned, which are those figured in No. 1, Pl. XXI (see Fig. 3 hereof), Ancient Monuments. The mound referred to is that designated in this figure as a "Square pyramidal mound." It was carefully explored by my assistant, Mr. H. L. Reynolds, whose report is as follows:

THE "PYRAMIDAL MOUND," BAUM WORKS.

This mound is distant from Mr. Middleton's station No. 28 in his recent survey of these works N. 21° 30′ W. 1,420 feet. In the work of Messrs. Squier and Davis the height is given as 15 feet and diameter 125 feet. Its present height is 12 feet above the level of the surrounding surface, and its present diameter from 135 to 140 feet. This difference is due to the annual disturbance of its surface by plow and freshet. The same agencies have likewise destroyed its pyramidal form, and it resembles now, instead, an upturned wash basin. The mound was composed for the most part of clay mottled considerably with black loam and slightly in some places with patches of a grayish plastic lime. Two cross-trenches were sunk due north and south and east and west, respectively. The

breadth of these at the side was from five to six feet, but as they penetrated inwards they widened gradually so that at the center the excavation became 13 feet in diameter. Considerable lateral digging was done from these trenches to uncover skeletons and other indications appearing in their sides.

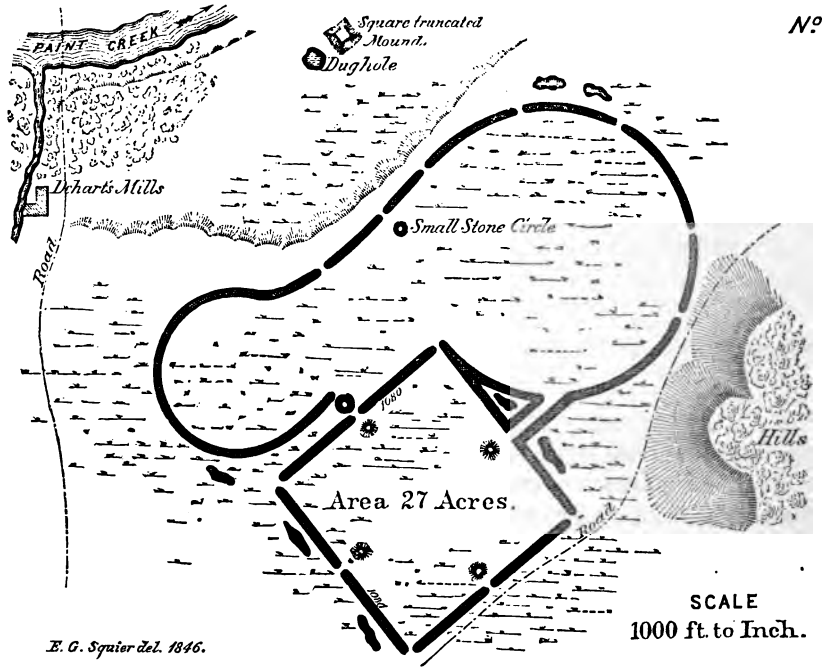

FIG. 3. Copy of Fig. No. 1, pl. XXI, Ancient Monuments.

Two series of upright post molds, averaging 5 inches in diameter, equi-distant 10 inches, and forming a perfect circle 36 feet in diameter, constitute a pre-eminent feature of this mound. Within these circular palings the mound was penetrated systematically by thin seams of fine sand sagging in the center and averaging 1 foot apart. Resting upon the natural black loam at the bottom, timbers averaging 8 inches in diameter radiated from the center, and in the south and west trenches were noticed to extend continuously to the posts. These timbers were detected, for the most part, by their burnt remains, and also by the molds of dark earth in the yellow clay produced by the decomposition of wood. Directly over these timbers was a horizontal line of decayed and burnt wood, but mostly decayed, averaging half an inch thick. The upright post molds of the lower series were very distinct, and measured 5 feet in vertical height. In one was found a small sliver of what appeared to be black walnut. Several of them contained the burnt remains of wood, and in many of these instances the black bark was clinging to the sides.

Separating this from the superstructure, as will be seen by reference to Fig. 4, was a thin sagging streak of burnt clay. Here and there

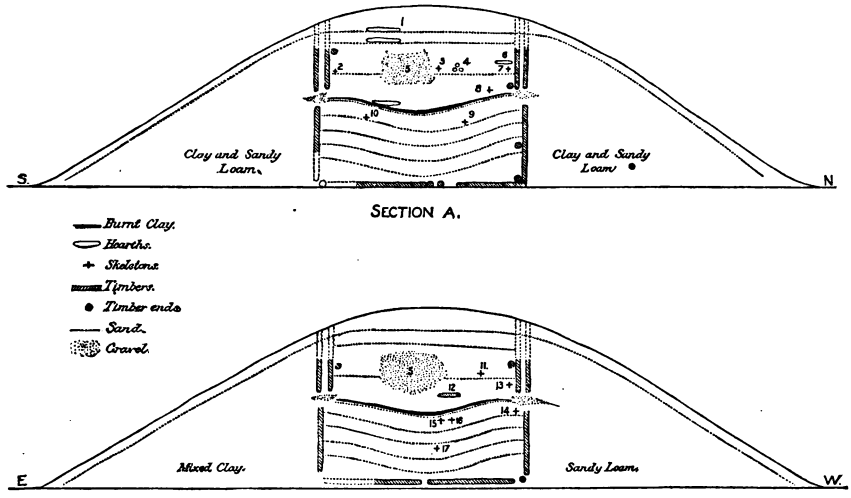

FIG. 4. Sections A and B of Pyramidal Mound, Baum works.

upon its surface scant traces of black wood ashes were seen, while a small quantity of white bone ashes lay scattered upon its western border. This burnt streak overlaid a thin sand seam, below which it seems it could not penetrate. The post molds of the superstructure consisted of a double row, the outer line being uniformly directly over the lower series in a vertical line, and separated from the latter entirely around the circle by a solid line of gravel. The two rows of the upper structure averaged 18 inches apart. Both might have penetrated originally beyond the surface of the mound, since they were discovered between 1½ and 2 feet beneath the surface, which had been considerably plowed. Horizontal timber molds, a little smaller in diameter, filled in places with charcoal, could be distinctly seen lying against the side of each line of posts at the points shown in the figure. These appear to have been cross-beams or stays used for bracing purposes. In the eastern trench a gap 3 feet and 2 inches wide was noticed by the absence of post molds in both upper and lower series.

Within the area inclosed by these posts, all the skeletons were interred. These lay at different depths and in different positions, the favorite or predominant one, at least in the upper portion, being just inside and alongside of the inner circle of palings. The skeletons unearthed were all in a remarkably good state of preservation. None of them could have been intrusively buried, for the stratification above them was not disturbed. All excepting Nos. 15, 16, and 17, lay upon one or another of the thin seams of sand. All except No. 6 lay stretched out at full length. The latter lay partly upon the side with knees

drawn up and head crouched down upon the ribs as though originally placed in a sitting posture. All except Nos. 10 and 11 had the arms and hands placed at the sides. The right arm of skeleton No. 10 lay bent across the stomach. The right arm of skeleton No. 11 was bent so that the hands touched the chin. From both jaws of this latter skeleton all the teeth had been extracted before interment.

With skeleton No. 1 a bone implement was found at the back of the cranium, and an incised shell and fragments of a jar at the right side of it. With skeleton No. 2, which was that of a child about ten years old, a small clay vessel was found 5 inches behind the cranium. At the left hand of skeleton No. 3 was a shell such as is found among the sands of Paint Creek. A bone implement was at the back of the cranium of No. 4. With skeleton No. 7 were found a lot of small semi-perforated shell beads and two bone implements directly back of the cranium. By the right side of the cranium were the perfect skull and jaws of a wolf, and beneath this were two perforated ornaments of shell. In the right hand was a shell, such as is found in the creek near by, while in the left was a pipe fashioned from stone.

At the right of the feet of this skeleton was the extremity of an oblong ash pit, about 4 feet long and 2 feet broad, and 1 foot 10 inches in depth. It was filled with white ashes which were evidently those of human bones since none but human bones could be identified. In these ashes and compactly filled with them was an earthen pot. It lay at the right of the feet of skeleton No. 7. It was lifted out of the ashes with great care, but the weight of its contents and its rotten condition caused it to break in pieces before it could be replaced upon the ground. Numerous other pieces of pottery of a similar character were found in these ashes, and it is not improbable, from the indications, that all these ashes were originally placed in pots before interment. A perforated shell dish two inches in diameter and a lump of soggy sycamore wood were gathered from the ashes. Neither wood nor shell bore any signs of having been burnt. These ashes could not have been buried intrusively since the sand layer above them was undisturbed.

Skeleton No. 9 lay 7 feet deep and a half foot below the general burnt streak. It was originally covered with a wooden structure of some kind, for the cores of two red cedar timbers were resting lengthwise upon the body, and the burnt remains of probably two others could be plainly seen on each side placed parallel to those upon the body. This red cedar was still sound, but the white wood which envelopes the red cores seemed to be entirely in a charcoal condition. The indications are that these timbers were originally 1 foot above the body, for the earth to that extent over the whole length of the body was very soft. The timbers were noticed to extend slightly beyond the head and feet, while the head upon which they lay was upon its right side. The earth above them was a mixture of clay and fine sand, and peculiarly moist. The length of this skeleton to ankle bones was 6 feet

and 1 inch. Two bone implements were found at its head, and at its right side near the head were two fragments of polished tubes and a hollow point of bone which bore unmistakable *signs of having been shaped with a steel knife* (see Fig. 5). These bone implements were found beneath the right elbow of skeleton No. 10. Skeleton No. 11 corresponded in level and conditions to skeleton No. 9. The timber, however, seemed to have nearly all decayed, since only a few small pieces of red cedar could be gathered, and scarcely any traces of black ashes could be seen. The earth, however, for about a foot above was very soft, and two timber molds at this level were distinctly traceable, extending from the direction of the skeleton's side to a foot and a half beyond its feet. Bones of deer and bear, stag antlers, mussel shells, and many fragments of coarse pottery were found in the west trench 9½ feet beyond the post molds.

It will be observed, if reference is had to the figure, that Nos. 1, 2, 5, and 7 are all upon the same sand layer as Nos. 4 and 6. Nos.

FIG. 5. Bone from Pyramidal Mound.

9, 11, and 12 also correspond in depth, but they did not, like the others, rest upon sand. Fragmentary human bones, disturbed by the plow, were found corresponding in depth to the topmost sand streaks shown in the diagram. Black walnut timber, measuring 4 feet and 5 inches above the general burnt streak, was found in a decayed and soaked condition at the point indicated in the figure. One end bore the marks of having been burnt. The soil around it was mostly a moist dark loam mixed with patches of what has been above described as a grayish plastic lime.

A foot and a half beneath the surface and a little to the southeast of the center, a curious double fire-bed or hearth was uncovered. It was about 5 feet in diameter. Uppermost was a layer of white ashes varying from one to two inches in thickness. They were the ashes of burnt shell and bone, but no bone could be found sufficiently large to determine whether or not it was human. Beneath this was burnt clay from 4 to 5 inches thick, resting upon a layer of sand, which at this point was between 2 and 3 inches deep. The surface of this sand was quite hard. Directly beneath it came another bed of ashes of equal thickness with the one above, and of like composition except that it contained a quantity of black wood ashes and several broken pieces of pottery. Below this appeared burnt clay again, from 4 to 6 inches deep, resting as before upon a thin layer of sand.

A hearth somewhat similar to this, but lacking its double feature, lay almost directly beneath this last upon the general burnt streak that has been heretofore described.

This mound is situated upon the edge of the first general bottom from Paint Creek, which, though protected by a huge levee, is annually inundated. In overflow times the smaller circle of the adjoining inclosure is almost entirely submerged, and the summit of the mound is the only land visible above a broad expanse of water. Around the mound, upon all sides, particularly to the east, are traces of former Indian occupation. Numerous fragments of pottery, similar in texture, fabrication, and ornamental features to those found in the mound, bestrew the plowed ground. These were intermingled with the valves of mussel shells, pitted stones, shell disks, human bones, arrow-heads, pieces of perforated stone gorgets, and innumerable quantities of chipped flint. Specimens of all were collected and forwarded to Washington with the relics taken from the mound.

REMARKS.

As it is not our intention to attempt at this time a full discussion of the questions raised by the data presented in the preceding pages, we shall limit our remarks chiefly to suggestions.

The close approximation to geometrical regularity in the Observatory and High Bank circles, and the Newark, Liberty Township, and Baum squares is to be admitted beyond further question. The approach to regularity in the octagons at Newark and High Bank, though deserving notice, is not so close as in the square and circular inclosures mentioned.

The first question which presents itself in view of these facts is, How are we to reconcile them with the theory that the works were built by Indians?

As before stated, we shall not attempt at this time a thorough discussion of this and other questions which arise in reference to these ancient works; nevertheless we may as well suggest some thoughts and note some facts which may aid in solving the problems.

A careful study of these works and of all the data bearing upon the questions regarding them, will satisfy any one, not biased by a preconceived theory, that their characteristics are essentially aboriginal. In other words, there is nothing in them or connected with them contradictory to the theory of their Indian origin, except it be the single fact that a few of them approach very nearly to true geometrical figures. That it was a custom among the Indians north and south to build circular inclosures and forts, is fully attested by history; it is also known that some of the Indian forts in the northern section were polygonal, especially those built by Iroquois tribes. There is, therefore, nothing in the form or arrangement that is inconsistent with Indian ideas and usages. On the other hand, there is nothing in their form or construction consistent with the idea that their conception is due to European influence. There are, however, indications relating to individual works which forbid this idea. I will mention but one of these.